

10/540403

JC20 Rec'd PCT/PTO 23 JUN 2005

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Clamart, 07 March 2005

International Patent Application no. **PCT/EP 03/13146**  
Applicants: **Services Pétroliers Schlumberger et al.**  
Our Ref: **WO 21.1066**

Dear Sirs,

I refer to the Written Opinion dated November 8, 2004 and enclose herewith triplicate copies of an amended set of claims to replace the claims presently on file. Amended description page 13 is also provided so as to withdraw former lines 1-4.

With regard to the specific comments in item V of the written opinion, the applicants comment as follows:

The new set of claims is believed to overcome the objection of novelty raised against claims 1 and 11 as filed. Amended claims 1 and 9 include respectively technical features from former claims 4 and 15 as filed and are also based on description and drawings 7-8.

None of the cited documents discloses apparatus having two transducers with radially offset front faces as claimed in new claims 1 and 9. This technical feature enables accurate measurement of the velocity of the ultrasound pulse in the mud independently of any external data or of the borehole diameter.

The applicants believe that this response addresses the issues raised by the examiner and request that a favorable international preliminary examination report be issued forthwith.

Yours faithfully,

  
Hélène RAYBAUD  
European Patent Attorney

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1- A method for determining a velocity of ultrasound propagation in a drilling fluid in a downhole environment, comprising:

- disposing a first ultrasound transducer (37) adjacent to a second ultrasound transducer (39) such that the front face (37f) of the first transducer (37) is offset from the front face (39f) of the second ultrasound transducer (39) by a predetermined radial offset distance ( $\Delta D_f$ ).
- emitting an ultrasound pulse into the drilling fluid in a borehole using the first ultrasound transducer (37);
- detecting the ultrasound pulse after the ultrasound pulse has travelled through the drilling fluid a distance (d); and
- determining the velocity of ultrasound propagation from the distance (d) and the travel time (t).

2- The method according to claim 1, wherein the detecting the ultrasound pulse is performed with the first ultrasound transducer (37).

3- The method according to claim 1, wherein the detecting the ultrasound pulse is performed with the second ultrasound transducer (39).

4- The method according to claim 1, wherein the detecting the ultrasound pulse is performed with both the first and second ultrasound transducer.

5- The method according to claim 4, further comprising determining a borehole diameter ( $D_{bh}$ ) using the predetermined offset distance ( $\Delta D_f$ ) and a difference in travel times ( $T_2 - T_1$ ) for the ultrasound pulse to be detected by the first ultrasound transducer (37) and the second ultrasound transducer (39).

6- The method according to claim 1, wherein the detecting the ultrasound pulse is performed by the first ultrasound transducer (37), and wherein the method further comprises:

- emitting a second ultrasound pulse into the drilling fluid in the borehole using the second ultrasound transducer (39); and

detecting the second ultrasound pulse after the second ultrasound pulse has traveled through the drilling fluid a distance  $(d + 2\Delta D_f)$  using the second ultrasound transducer (39).

7- The method according to claim 6, wherein the ultrasound pulse and the second ultrasound pulse are emitted simultaneously.

8- The method according to any of claims 1 to 7, wherein the drilling fluid is located in an annulus between a tool and a borehole wall.

9- An apparatus for determining a velocity of ultrasound propagation in a drilling fluid in a downhole environment, comprising:

a first ultrasound transducer (37) disposed on a tool; and

a second ultrasound transducer (39) adjacent to said first ultrasound transducer such that the front face (37f) of the first transducer (37) is offset from the front face (39f) of the second ultrasound transducer (39) by a predetermined radial offset distance ( $\Delta D_f$ ).

circuitry (82) for controlling a timing of an ultrasound pulse transmitted by the first ultrasound transducer (37) and for measuring a time lapse between ultrasound transmission and detection after the ultrasound pulse has traveled a distance (d).

10- The apparatus according to claim 9, wherein the first ultrasound transducer (37) and the second ultrasound transducer (39) are disposed on an outside surface of the tool.